

industry does not consist of a large number of firms, none of which serves a large share of the market.

Economists consider the number and size distribution of firms in a market to be important initial indicators of the likelihood of noncompetitive behavior.<sup>10</sup> Collusive arrangements, whether explicit or tacit, are more likely when there are only a few firms, simply because coordination is easier. Similarly, the costs of monitoring the behavior of others and enforcing any collusive arrangement by punishing "cheaters" are lower when there are few industry participants.<sup>11</sup> The size distribution of firms also affects the ease of coordination. A small number of very large firms may serve as coordinators in an industry that also includes many small firms.

However, economists also recognize that the competitive outcome, where prices are driven to marginal costs, may obtain even in industries with as few as two firms.<sup>12</sup> Theoretical models of the strategic interactions between duopolists predict a broad range of outcomes, from monopolistic to perfectly competitive.<sup>13</sup> In

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<sup>10</sup>M. Spence, "Tacit Co-ordination and Imperfect Information," Canadian Journal of Economics XI (1978), pp. 497 and 499.

<sup>11</sup>J.S. Bain, "Relation of Profit Rate to Industry Concentration," Quarterly Journal of Economics LXV (1951), pp. 205-206.

<sup>12</sup>The best-known model demonstrating this result is found in J. Bertrand, "Théorie Mathématique de la Richesse Sociale," Journal des Savants, 1883, pp. 499-508.

<sup>13</sup>A large body of economic literature, predicting a range of competitive outcomes, is reviewed in J. Tirole, The Theory of Industrial Organization (Cambridge, MA: The MIT Press, 1988), pp. 225-308.

these models, firms choose whether to cooperate and at which price. The outcome depends on the reaction that each firm expects from its competitor to changes in its own price or output. This, in turn, determines the gains that each firm expects from undercutting a noncompetitive price, and the expected cost of being punished if such deviation is detected. Even duopolists do not necessarily react to each other's actions in ways that maximize joint profits: a duopoly is not the same as a monopoly.

The decision rules that comprise a firm's competitive strategy are difficult to infer from its observed behavior. Nonetheless, economists have identified a number of significant factors, in addition to the number of its rivals, that influence the strategies each firm pursues, and thus help to determine how close to the competitive outcome the industry's performance will be.<sup>14</sup> These are factors that make collusive practices more or less difficult to establish, and affect the ease with which deviations from a collusive outcome can be detected and punished. Several of these factors are likely to influence the performance of the cellular service industry, albeit to varying degrees.

One of the most striking features of the mobile communication industry is the rapid pace of technological innovation and diffusion. Transmission technology has evolved from analog to digital, and cellular telephones have become truly portable, shrinking to pocket size. The rate of technological change and the

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<sup>14</sup>G. J. Stigler, "A Theory of Oligopoly," Journal of Political Economy 74 (1964), pp. 44-61.

resulting speed with which the customer base is growing are two influences that economists consider procompetitive.

The rapid technological change in the provision of cellular service imparts a high degree of variability to the services offered and the prices of those services. In these circumstances, a collusive agreement is difficult to maintain, because the price of each new service must be integrated into the existing price structure.<sup>15</sup> As providers adopt new technologies, the introduction of new service packages offers opportunities to "cheat" on a noncompetitive agreement without provoking the "punishment" that might otherwise occur, because it is difficult for a rival to determine what the appropriate price of the new service should be. If new services are offered at more competitive prices, because it is easier to deviate from a collusive agreement when products are changing, or even if rivals only perceive that the new services are being offered at prices that are "too low" because they do not know what those prices should be, a collusive agreement may be difficult to establish and maintain.

The rapid rate of technological innovation not only hinders the smooth functioning of a collusive pricing agreement but, by leading to rapid market growth, also may weaken the incentive for firms to participate in such agreements. When markets are growing

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<sup>15</sup>R.A. Posner, Antitrust Law: An Economic Perspective (Chicago, IL: The University of Chicago Press, 1976), pp. 59-60.

rapidly, demand tends to be more inelastic, so the gains from deviating from a collusive price are greater.<sup>16</sup>

The importance of technological innovation in the provision of cellular services may lead to low prices for a third reason. Economic models predict there may be gains to pricing aggressively in industries characterized by significant learning economies. By keeping its prices low, a firm can increase production and achieve cost savings more rapidly as it moves down its learning curve.<sup>17</sup> These models predict that economic performance will be better if, instead of many small firms, the industry consists of a few large, long-run profit-maximizing firms. The predictions of such models are supported by experiences in the semiconductor and related electronics industries.<sup>18</sup>

The history of the players' competitive behavior shapes their future behavior as well.<sup>19</sup> Early in the history of cellular services, when the wireline carriers already were established and the nonwireline carriers were just beginning to serve customers, the new providers had an especially strong incentive to initiate price cuts. While they would realize lower revenue from their

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<sup>16</sup>J.J. Rotemberg and G. Saloner, "A Supergame-Theoretic Model of Price Wars During Booms," American Economic Review 76 (1986), pp. 390-407.

<sup>17</sup>A.M. Spence, "The Learning Curve and Competition," The Bell Journal of Economics 12 (1981), pp. 49-70.

<sup>18</sup>F.M. Scherer and D. Ross, Industrial Market Structure and Economic Performance, Third Edition, (Boston, MA: Houghton Mifflin Co., 1990), pp. 373-374.

<sup>19</sup>Posner, op. cit., p. 61.

small bases of existing customers, this would be more than offset by revenues from the new customers they were able to attract.<sup>20</sup> The newer providers of long-distance telephone service faced similar incentives to price competitively against AT&T. Competition in the provision of long-distance service is considered by many to have increased significantly when start-up firms began offering service alternatives to AT&T, despite the fact that the structure of the industry is still quite concentrated.

Nor does it appear that the cellular service industry has established stable market-sharing arrangements as the nonwireline carriers' shares have grown to a substantial size. An example of shifting market shares is seen in Detroit. In that market in 1987, PacTel and Ameritech had 51.2 and 48.8 percent of the subscriber base, respectively. An industry analyst estimated that at year end in 1991, Pactel's share had fallen to 40.5 percent, and Ameritech's had risen to 59.5 percent.<sup>21</sup>

A final characteristic of cellular service markets that weakens industry cohesion, and thus the ability of firms to raise prices, is the heterogeneity of product offerings. Although the quality of airtime may not vary significantly across providers, an array of service packages typically is offered, none of which may

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<sup>20</sup>The Department of Justice and Federal Trade Commission Merger Guidelines of April 2, 1992 (p. 40) state that incentives to cheat on collusive agreements are greater the larger the proportional increase in sales from cheating and the smaller the base of sales prior to cheating.

<sup>21</sup>From Press Release, "Shostack Releases Cellular Market Quarterly Review — Shows Cellular Sales and Subscriber Counts for Each Major Market," Silver Spring, Maryland, May 25, 1992, p. 3.

be directly comparable between competing providers.<sup>22</sup> The lack of an obvious basis for comparing service prices increases the cost of monitoring and punishing deviations from any collusive agreement in the short term.<sup>23</sup> With the introduction of Personal Communications Services (PCS), product heterogeneity will increase, and the cost of monitoring a collusive agreement will increase because price changes that reflect differences in service quality will be difficult to distinguish from price changes that undercut a tacit agreement.

The feature of the cellular industry that is most likely to raise competitive concerns among economists is the existence of a government-mandated barrier to further entry. The threat of entry in response to a profit opportunity should incumbents set artificially high prices often may have a dampening effect on the prices that are observed.<sup>24</sup> Ease of entry is a powerful competitive force<sup>25</sup> that cellular providers have not had to confront. However, with the advent of PCS, together with the introduction of a number of new service providers, cellular operators may be subject to additional competitive discipline.

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<sup>22</sup>The quality of airtime will vary from time to time, however, if cellular providers fail to anticipate the growth in subscribers, leading to increased traffic congestion.

<sup>23</sup>K.W. Clarkson, and R.L. Miller, Industrial Organization: Theory, Evidence, and Public Policy (New York, NY: McGraw-Hill Book Company, 1982), pp. 335-336.

<sup>24</sup>F. Modigliani, "New Developments on the Oligopoly Front," Journal of Political Economy 66 (1958), pp. 215-232.

<sup>25</sup>Posner, op. cit., p. 49.

The nature of transactions in cellular services tends to favor the stability of an industry agreement not to compete, although industry practices indicate that a "repeat-purchase" aspect of the cellular subscriber may dominate. In effect, cellular providers compete for a particular customer each month, since the cost of switching to the alternate supplier is minimal.<sup>26</sup> Frequent and small transactions diminish the gains from deviating from a collusive agreement and provide ample opportunity for retaliation against suppliers that do so.<sup>27</sup> However, the incentives offered consumers for initial subscriptions and the commissions paid to agents, which are determined by the expected lifetime of a subscription, represent an investment on the part of cellular providers. These investments signify that cellular providers expect an ongoing relationship with most customers.<sup>28</sup> To the extent subscribers represent a long-term stream of future monthly revenues, cellular service providers have an incentive to compete aggressively for new customers.<sup>29</sup>

The role of capacity in cellular services also has an ambiguous impact on the likelihood of sustained collusive behavior.

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<sup>26</sup>The activation fee typically is waived when a subscriber switches to the other provider. The phone must be brought in for reprogramming, however.

<sup>27</sup>Stigler, op. cit., pp. 47 and 51.

<sup>28</sup>On average, 15 percent of a cellular carrier's subscribers switch to the other provider during the course of a year, an observation made by Thomas E. Wheeler, the President of the CTIA, in a speech on October 21, 1992, entitled "The Wireless Century," p. 4.

<sup>29</sup>Stigler, op. cit., p. 51.

The capacity to serve subscribers increases in "lumpy" increments due to the nature of the technology. After the addition of new capacity, providers can serve new subscribers at low marginal cost. This scenario creates some pressure to undercut noncompetitive prices. On the other hand, economists recognize that idle capacity held by a price leader may serve to enforce collusive agreements.<sup>30</sup> The enforcement mechanism is the threat that the firm with significant excess capacity can flood the market with product to punish firms that undercut the noncompetitive price. However, economists tend to view excess capacity as a more important factor in industries experiencing cyclical or permanent downturns, a condition inapplicable to the past or foreseeable future of the cellular industry.

Economists recognize that an assessment of the degree of market competition must look beyond the number and size distribution of firms to factors that impede or foster collusive behavior. Clearly, there are characteristics of the cellular industry discouraging collusion and factors facilitating its practice. These characteristics by themselves are too complex to predict the competitive outcome. However, the observed performance in the cellular industry, most notably the rapid growth of the subscriber base and the steady decline in service prices, is consistent with competitive behavior.

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<sup>30</sup>Department of Justice and Federal Trade Commission Merger Guidelines, April 2, 1992, p. 40, footnote 19.



AN ECONOMIC ANALYSIS OF ENTRY BY CELLULAR OPERATORS  
INTO PERSONAL COMMUNICATION SERVICES

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## Introduction and Conclusions

On August 14, 1992, the Federal Communications Commission released its Notice of Proposed Rule Making and Tentative Decision in the Matter of the Amendment of the Commission's Rules to Establish New Personal Communications Services.<sup>1</sup> The Notice solicits comments on a broad range of issues concerning the allocation of radio spectrum for Personal Communications Services (PCS), including the amount of spectrum to be allocated, the number of licenses to be issued, the manner of initial licensing, and the regulatory structure the FCC should establish for PCS.

One set of issues on which the Commission seeks comments is eligibility requirements for PCS licenses. Among these issues is whether incumbent cellular licensees should be permitted to acquire PCS licenses in their service areas. In the Notice, the Commission observes that permitting cellular operators to acquire PCS licenses within their service areas could facilitate anticompetitive behavior by reducing the number of independent suppliers of competing cellular and PCS services.<sup>2</sup>

While raising this competitive concern, the Commission also

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<sup>1</sup>Notice of Proposed Rule Making and Tentative Decision, In the Matter of Amendment of the Commission's Rules to Establish New Personal Communications Services, GEN Docket No. 90-314, ET Docket No. 92-100, released August 14, 1992 (hereafter Notice).

<sup>2</sup>Notice, para. 62 and para. 64. Competitive concerns would not be raised, however, were a cellular service provider to acquire a PCS license outside its service area. (Notice, para. 62) Whether or not it allows cellular licensees to acquire additional spectrum inside their service areas, however, the Commission would permit them to use part of their existing spectrum to provide PCS-type services. (Notice, para. 70)

points out that production efficiencies may be attained if cellular licensees were also permitted to supply personal communications services. If there are economies of scope in supplying PCS and cellular services, for example, a single firm supplying both would achieve lower average costs for each service than would two firms each supplying one of the services.<sup>3</sup> In its 1981 Report and Order establishing commercial cellular service,<sup>4</sup> the Commission took efficiencies in production into account, and has indicated a willingness to do so again in the case of PCS.

This paper is a response to the FCC's request for comments on whether cellular providers should be allowed to obtain additional spectrum for PCS within their cellular service areas. Our comments are directed to an analysis of two issues: (1) whether and in what circumstances competitive problems would arise were cellular providers to acquire additional PCS spectrum within their cellular service areas; and (2) whether and in what circumstances there would be offsetting efficiencies from permitting incumbent cellular providers to offer service using the spectrum the Commission proposes to allocate to PCS.

Because PCS is not a well-defined term, and because it is difficult to forecast the ways in which PCS might develop, it is

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<sup>3</sup>Notice, para. 27.

<sup>4</sup>Report and Order in the Matter of an Inquiry into the Use of the Bands 825-845 MHz and 870-890 MHz for Cellular Communications Systems; and Amendments of Parts 2 and 22 of the Commission's Rules Relative to Cellular Communications Systems, CC Docket No. 79-318, adopted April 9, 1981; 86 FCC 2d 469 (1981); hereafter 1981 Report and Order.

not easy to answer these questions. In this paper, we consider a number of possible forms that PCS might take in order to analyze the competitive and efficiency issues raised by the Commission. Each of the alternatives that we examine is designed to illustrate a form of PCS that has particular implications for the policy that should be pursued. At the same time, we recognize that no one can be certain which, if any, of these forms may evolve. As a result, we believe that the FCC should adopt a policy that is adaptable to future developments rather than one that is based on a single view of the future of PCS. In this regard, we are able to reach two broad conclusions about whether to permit incumbent cellular operators to acquire licenses to offer services in the band the Commission proposes to allocate to PCS.

First, although there may be grounds for concerns about the competitive impact of allowing incumbent cellular operators to offer PCS, we conclude that it is easy to overstate these concerns. The impact of such acquisitions depends on the amount of spectrum allocated to PCS, on the number of new licenses that are issued, on the amount of spectrum that cellular operators are permitted to acquire, and on the precise form that PCS takes. Under quite plausible circumstances, permitting incumbent cellular operators to acquire some portion of the PCS spectrum does not raise competitive concerns.

Second, we find that, depending on the form PCS takes, significant production efficiencies may result from permitting incumbent cellular operators to acquire a portion of the PCS

spectrum. These efficiencies can arise through economies of scale, where new services require more spectrum than incumbent operators can make available from their current allocations, and economies of scope, where PCS services can be provided at lower cost by cellular operators than by new firms offering only PCS service.

We find that no competitiveness problem would arise from cellular providers acquiring a limited amount of spectrum even if PCS were a perfect substitute for traditional cellular service. Moreover, if PCS were not a close substitute, or if there are economies of scale in providing PCS or economies of scope between cellular and PCS, consumers would benefit further if cellular operators were permitted to acquire even more spectrum in order to supply PCS.

A blanket prohibition against the acquisition by cellular operators of the spectrum allocated to PCS would be ill-advised. Such acquisitions pose only limited potential for anticompetitive effects under certain circumstances, and potentially significant efficiencies in others. Since the Commission would not bar cellular operators from acquiring PCS spectrum if it were certain that these circumstances would obtain, and since there exists a presumption in favor of permitting open entry, the Commission should be willing to permit cellular operators to acquire some PCS spectrum in the face of the considerable uncertainties that exist about the future of PCS.

### The Initial Cellular Licensing Decision

In its 1981 Report and Order authorizing cellular communications systems on a commercial basis, the Federal Communications Commission concluded that licensing two cellular carriers in each service area would best serve the public interest, convenience, and necessity. In establishing a duopoly structure for the supply of cellular services, the FCC sought to balance the benefits arising from economies of scale with those resulting from competition.

Only seven years before, the technical complexity and expense of cellular systems, together with the large amount of spectrum required for their economic viability, had persuaded the FCC that only one cellular system should be licensed in each service area.<sup>5</sup> Because of significant changes in both regulatory policies and cellular technology in the ensuing years, however, the Commission reconsidered its earlier determination to license only a single cellular operator.

By 1981, the FCC believed that most of the economies of scale in the supply of cellular service could be achieved at a level of output that would accommodate two efficient cellular operators in each service area. In the Commission's view, two cellular licensees in each area "while not providing the most competitive market structure, would provide some competitive advantages, including the fostering of different technological approaches,

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<sup>5</sup>Second Report and Order in Docket No. 18262, 46 FCC 2nd 752 (1974).

diversity of service options and some degree of price competition which otherwise would not be present."<sup>6</sup>

### The Performance of the Cellular Industry

From its beginning, the cellular telephone communications business has been characterized by rapidly increasing volume, declining prices, expanded service offerings, and significant technological change. The number of cellular telephone subscribers, only 91,600 in January 1985, had grown to an estimated 8.8 million by June 1992.<sup>7</sup> Cellular subscribers are projected to number 19 million by 1995 and 38 million by 2001.<sup>8</sup>

Contributing to this growth has been a steady decline in the costs of owning and using cellular telephones. For example, when adjusted for inflation, the unweighted average of the lowest published rate for access and 250 minutes of prime time use in the 10 largest cellular service areas in 1991 was only 62 percent of its 1983 level.<sup>9</sup> Mobile cellular telephone prices have declined even more, while function and feature improvements have enhanced their quality. When adjusted for inflation, the total 1991 cost of owning and using a cellular telephone was only 44 percent of the

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<sup>6</sup>1981 Report and Order at 474.

<sup>7</sup>Cellular Telecommunications Industry Association, Industry Data Survey, June 30, 1992, p. 1.

<sup>8</sup>Linden Corporation, Cellular Network Technology, End User Requirements, and Competition to the Year 2001, p. 244.

<sup>9</sup>Data are from Herschel Shosteck Associates, Ltd., Cellular Market Forecasts, Data Flash, September 1992.

1983 cost.<sup>10</sup>

Cellular subscribers also have benefitted from a continually expanding variety of services. Today, cellular providers offer a number of value-added services, including information services and features such as voice mail, call forwarding, and call waiting. There have been major advances in data transmission as well, including portable facsimile and wireless transmission for laptop computers. New services continue to be developed.

Recent technological advances have enabled cellular systems to expand their capacity. Several of these innovations have occurred in the conventional or analog cellular technology.<sup>11</sup> The conversion to digital technology, despite the substantial investment required, promises to yield even greater increases in system capacity and lower average costs for cellular operators.<sup>12</sup>

#### Competition in the Supply of Cellular Services

The cellular service industry's performance is the kind that economists associate with a young industry driven by market forces

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<sup>10</sup>Data are from Shosteck, op. cit., and measure the "drive away" price of a single mobile telephone, including antenna, installation, and first-year maintenance.

<sup>11</sup>H. Shosteck, "The question marks over PCNs," Mobile Europe, January 1991, no pagination.

<sup>12</sup>Coopers & Lybrand, Technological Change and the Cellular Telecommunications Industry (November 1991), pp. 59-60. During a transition period, cellular phones will be dual mode, adaptable to both digital and analog systems.



and developing in a competitive context.<sup>13</sup> This has occurred without a competitive structure, as defined by economists. Economists have recognized, however, that the behavior of firms and an industry's performance can approximate the competitive outcome even if the industry does not consist of a large number of firms, each with a small share of the market.<sup>14</sup>

Collusive arrangements, whether explicit or tacit, are more likely in markets with few firms, simply because the necessary coordination, monitoring, and enforcement functions are easier.<sup>15</sup> However, the competitive outcome may be obtained even in industries with as few as two firms.<sup>16</sup>

Whether firms cooperate and at what price depends on the expected gains from undercutting a noncompetitive price and the expected cost of being punished if such deviation is detected.

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<sup>13</sup>While this record of performance is consistent with a competitive industry, it does not prove that the industry is necessarily competitive, since even a monopolist facing conditions of increasing demand and reduced costs is likely to earn greater profits by lowering price, expanding output, and making innovations in products and production methods.

<sup>14</sup>Economists call a market structure competitive when entry is easy, firms are numerous, and no firm has a large market share. As we point out in the text, the performance of a market can be competitive even if its structure is not.

<sup>15</sup>J.S. Bain, "Relation of Profit Rate to Industry Concentration: American Manufacturing, 1936-1940," Quarterly Journal of Economics 65 (1951), pp. 205-206.

<sup>16</sup>The best-known model that demonstrates this result is from J. Bertrand, "Theorie Mathematique de la Richesse Sociale," Journal des Savants (1883), pp. 499-508. A large body of economic literature predicting a range of competitive outcomes is reviewed in J. Tirole, The Theory of Industrial Organization (Cambridge, MA: The MIT Press, 1988), pp. 225-238.

Economists have identified a number of factors that make collusive practices more or less difficult to establish and that affect the ease with which deviations from a collusive outcome can be detected and punished.<sup>17</sup> Several of these factors are likely to influence cellular service industry performance, albeit to varying degrees.

Competing cellular providers typically offer an array of service packages, none of which may be directly comparable.<sup>18</sup> The lack of an obvious basis for comparing service prices increases the cost of monitoring and punishing deviations from any collusive agreement. As cellular providers take advantage of new technologies to offer new services, the opportunities for "cheating" on a noncompetitive agreement without provoking "punishment" increase still further. This occurs because it is difficult for a rival to determine what the appropriate price of the new service should be.

The tremendous cellular service growth opportunities give managers weaker incentives to coordinate their behavior to preserve industry profits than would a shrinking market. This is because the benefit of undercutting a noncompetitive price is greater when demand is relatively high.<sup>19</sup>

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<sup>17</sup>G.J. Stigler, "A Theory of Oligopoly," Journal of Political Economy 72 (1964), pp. 44-61.

<sup>18</sup>Airtime quality will vary occasionally, as well, if cellular providers fail to anticipate subscription growth, leading to increased traffic congestion.

<sup>19</sup>J.J. Rotemberg and G. Saloner, "A Supergame-Theoretic Model of Price Wars During Booms," American Economic Review 76 (1986), pp. 390-407.

By keeping its prices low, a firm can increase production and achieve cost savings more rapidly as it moves down its learning curve.<sup>20</sup> The opportunity to achieve significant learning economies may lead cellular firms to price aggressively.<sup>21</sup>

The nonwireline carriers had an especially strong incentive to initiate price reductions upon entering the market. The lower revenue from the nonwirelines' small customer bases would be more than offset by revenues from new customers attracted by price cuts.<sup>22</sup> Historic behavior may influence subsequent competition.

Although entry has not been a source of competitive pressure for cellular providers in the past, the advent of PCS, together with the introduction of a number of new service providers, may bring additional competitive discipline. The introduction of Enhanced Special Mobile Radio (ESMR) will have a similar effect.

Frequent customer transactions and low switching costs diminish the gains from deviating from a collusive agreement and provide ample opportunity for retaliation against suppliers that do so.<sup>23</sup> Nonetheless, the initial subscription incentives and the

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<sup>20</sup>A.M. Spence, "The Learning Curve and Competition," The Bell Journal of Economics 12 (1981), pp. 49-70

<sup>21</sup>Ibid., p. 49.

<sup>22</sup>The Department of Justice and Federal Trade Commission Merger Guidelines of April 2, 1992 (p. 40) state that incentives to cheat on collusive agreements are greater the larger the proportional increase in sales from cheating and the smaller the base of sales prior to cheating.

<sup>23</sup>The activation fee typically is waived when a subscriber switches to the other provider. The phone must be brought in for reprogramming, however.

commissions paid to agents signify that an ongoing relationship is expected with most customers.<sup>24</sup> To the extent subscribers represent a long-term stream of future monthly revenues, cellular service providers have an incentive to compete aggressively for new customers.

Economists recognize that an assessment of market competition must look beyond the number and size distribution of firms to factors that impede or foster collusive behavior. Clearly, there are cellular industry characteristics that discourage collusion and factors that facilitate its practice. The complex interaction of these characteristics makes predicting the competitive outcome difficult. However, the cellular industry's performance, most notably the rapid subscriber growth and the steady decline of prices, is consistent with competitive behavior.

#### What is PCS?

As discussed above, PCS is not a well-defined term. Indeed, at least four different views have appeared in discussions of PCS. Some providers of cellular service have described PCS as the third phase in the evolution of cellular technology, following service to automobiles and portable telephones. A second view is that PCS comprises several kinds of communications services, based on digital technologies, that will become competitive alternatives to

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<sup>24</sup>According to Thomas E. Wheeler, President of the CTIA, on average, 15 percent of a cellular carrier's subscribers switch to the other provider during the course of a year. See "The Wireless Century," Speech, October 21, 1992, p. 4.

cellular telephone services -- for example, CT-2 (second-generation cordless telephones) or ESMR. A third view is that PCS is simply a synonym for wireless or mobile telecommunications services, one of which is cellular radio. Finally, one commentator has suggested that PCS is "more spectrum for something else," namely any and every new wireless concept that is proposed.<sup>25</sup>

A common feature of these views of PCS is that the subscriber can call or be called at any time wherever he or she happens to be. Telocator's PCS Section has defined personal communications service as "a broad range of individualized telecommunications services that enable people or devices to communicate independent of location."<sup>26</sup> PCS is expected to provide individuals with the ability to communicate independent of their location, access method (e.g., network or terminal device), and information format (e.g., voice, data, or graphics). Despite the similarities in concept among these alternative views, however, there are significant differences in application that make it difficult to analyze future competition in the supply of PCS.

The Commission has clearly recognized the difficulties in identifying the future of PCS when it defines the services broadly as "a family of mobile or portable radio communications services which could provide services to individuals and business, and be

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<sup>25</sup>G. Calhoun, Wireless Access and the Local Telephone Network (Boston: Artech House, 1992), p. 573.

<sup>26</sup>Telocator PCS Section, Marketing and Consumer Affairs Committee, Service Description Subcommittee, PCS Service Descriptions, July 22, 1992, p. 1.

integrated with a variety of competing networks"<sup>27</sup> and indicates that it intends for the term PCS "to encompass a family of services that would include services other than voice, such as data, imaging, and other new services."<sup>28</sup>

The difficulty in defining PCS is further revealed by examining the wide range of attributes that a single service may possess. Telocator has identified the following service attributes in its attempt to define PCS<sup>29</sup>:

A. Environment

1. Residence - Inbuilding
2. Residence - Neighborhood
3. Business - Inbuilding
4. Business - Campus
5. Public - Pedestrian
6. Public - Mobile

B. Call Termination

C. Call Origination

1. Residence/Business
2. Public

D. Mobility

1. Residence/Business
2. Public

E. Data

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<sup>27</sup>Notice, para. 29.

<sup>28</sup>Notice, para. 12.

<sup>29</sup>Telocator, op. cit.

F. Registration

1. Home
2. Roam

G. Privacy

1. Eavesdropping
2. Security

H. Grade of Service

I. Voice Quality

J. Integrated Enhanced Services

Clearly, with these many attributes, and with each attribute having many possible dimensions, the range of possibilities for PCS is very large indeed. Telocator lists 18 "Existing PCSs" and 5 "Emerging PCSs." Yet even this understates the number of such services, since many variations of each of these service exist.

Predicting How PCS Will Affect Competition

Because PCS is not a well-defined term, and because technologies are changing rapidly<sup>30</sup>, one cannot predict with any certainty which services will be offered under that rubric. As a result, it is difficult to analyze how alternative spectrum allocations will affect competition among the various Personal Communications Services that may emerge. PCS is not yet commercially available, and there is still considerable uncertainty about the precise features and functions, as well as the costs of

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<sup>30</sup>The FCC has authorized over 150 PCS experimental licenses in the past three years. Paragraphs 18 to 21 of the Notice provide an overview of these experiments.

production and prices, of the various services that may be introduced. It is these attributes of PCS that will determine the nature of their relationships with cellular service, that is, whether cellular and a particular PCS are close or poor substitutes, independent goods, or even complements in demand.

Because of the wide variety of Personal Communications Services being developed, and the uncertainty about their salient attributes, it is premature to conclude that PCS will necessarily be a competitive alternative or close substitute for cellular service.<sup>31</sup> Some Personal Communications Services, such as high-speed data service, would seem to be complementary in demand to traditional cellular service. Others, such as low-quality portable services, may be largely independent in demand. And even where PCS is clearly a substitute, it may be an alternative to cellular service only at certain levels of cost, price, and service quality.

The case of CT-2 illustrates the difficulty in assessing the effect of introducing a particular PCS. Since the technology does not permit incoming calls or call handoff, CT-2 will be an attractive alternative to cellular subscribers only if it is priced at a substantial discount from the price of cellular services. From the available information, it is by no means clear that suppliers of CT-2 services could achieve costs that would permit a

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<sup>31</sup>Even if the Commission believed that one of these outcomes was most likely, it should not act as if this outcome were certain. R.D. Luce and H. Raiffa, Games and Decisions (New York: John Wiley, 1957), p. 322, note that "For many policy purposes, point estimation seems to be a dangerous tool, for what in a given instance is the 'best guess' of a parameter may, indeed, be a 'poor guess' in actuality."



substantial price differential or, if they could, how cellular operators would respond in their pricing. Alternatively, CT-2 might become not a substitute for traditional cellular service, but rather simply a low-price/low-quality service that is provided to a different group of users.

#### PCS Policy in an Uncertain World

Assessing the effect on competition of permitting incumbent cellular operators to acquire a portion of the PCS spectrum is not an easy task. The difficulty arises because the Commission is, in effect, being asked to perform a study of market behavior without being certain about the technologies that will be employed and the services that will be offered in the PCS "market." Whether the effect on competition will be large, and whether there will be significant efficiencies, will depend on, among other things, whether PCS is a substitute for, a complement to, or independent of traditional cellular service. Which of these is the case cannot be determined on a priori grounds but will become known only as the PCS market evolves.

The services that may be provided as part of the "family of services known as PCS"<sup>32</sup> are many and varied. Moreover, which of these services will actually be offered cannot be predicted with great accuracy. The Commission has identified an extensive list of possible offerings "in addition to advanced forms of cellular

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<sup>32</sup>Notice, para. 1. Later, the Commission observes that "PCS is, of course, evolving and it is likely that a variety of services will be offered under the rubric of PCS...." (Notice, para. 98)